

# **Arrangement for Transferring Information/Structures to Wafers**

## **TECHNICAL FIELD**

**[0001]** The present invention relates generally to semiconductor manufacturing and an arrangement for transferring information/structures to wafers.

## **BACKGROUND**

**[0002]** Nano- or imprint lithography is used to transfer information or structures to a wafer by means of a metal or polymer stamp in that the stamp, which is provided with the corresponding information, is simply pressed into a soft auxiliary patterning layer situated on the wafer, e.g. a polymer layer, and the layer is thus correspondingly patterned. Imprint lithography, which can be used for feature sizes of around 50 nm, substantially simplifies the patterning of surfaces and can replace photolithography that is used otherwise.

**[0003]** The information/structures to be transferred are produced on the stamp by means of one of the known electron beam or laser lithography or optical lithography in conjunction with customary etching methods. In this case, the dimensions of the stamp correspond to those of a chip to be fabricated on the wafer. It emerges from this that the stamp in each case has to be positioned above a chip and oriented precisely. The stamp is then pressed into the auxiliary patterning layer, the information/structure being transferred into the latter. This operation is to be repeated until the entire wafer has been scanned in a manner similar to a wafer stepper.

**[0004]** This operation is very time-consuming and requires a precise prealignment of the wafer and then of the stamp relative to the wafer. Moreover, structures in the 50 nm range have

to be realized on the stamp, which requires a very sophisticated photolithography. That leads to considerable costs, especially as the stamps are indeed subject to a certain degree of wear.

## SUMMARY OF THE INVENTION

**[0005]** The preferred embodiment of the present invention provides an arrangement for transferring information/structures to wafers in a manner that can be realized cost-effectively. In one aspect, the invention relates to an arrangement for transferring information/structures to wafers using a stamp on which the information/structures to be transferred have been applied as elevated structures by means of suitable methods, for example a photolithographic method in conjunction with an etching method, and the wafer fixed on a chuck being provided with a plastically deformable auxiliary patterning layer.

**[0006]** In the case of an arrangement of the type mentioned in the background, advantage can be achieved by virtue of the fact that the dimensions of the stamp approximately correspond to those of the wafer. For example, the stamp is provided with the elevated information/structures essentially over the whole area and the stamp and the wafer are in each case provided with mutually assigned pairs of alignment marks in such a way that the stamp can be positioned in a predetermined position on the wafer by means of an infrared positioning system and can be pressed into the plastically deformable auxiliary patterning layer.

**[0007]** The preferred embodiment of the invention achieves a significant reduction in the costs of fabrication of the stamps and at the same time obviates one complete photolithography step. A significant cost saving is thus also achieved in wafer production.

**[0008]** In one particular embodiment of the invention, the alignment mark in the stamp and in the wafer are embodied as buried metal marks, the metal marks in the wafer being arranged in the first structure plane or metal plane.

**[0009]** The alignment marks are preferably in each case arranged in the edge region of the stamp and of the wafer, care being taken to ensure that the alignment marks are not concealed again by metal interconnects of further metallization planes in the course of further layer construction.

**[0010]** In a further refinement of the invention, each pair of alignment marks is assigned an infrared laser situated in the chuck and, above the stamp, an infrared camera.

**[0011]** A further embodiment of the invention provides for the stamp to be fixed to a stamp mount which can be positioned three-dimensionally in the X, Y and Z directions. As an alternative, the stamp may be fixed to a stamp mount which can be positioned two-dimensionally in the X and Y directions, the chuck being vertically movable.

**[0012]** Finally, the chuck is provided with an acceptance/transfer device for accepting/transferring a respective wafer from/to a handler, the acceptance/transfer device comprising preferably three pins which can be extended from the chuck from below against the wafer. A handler is to be understood to be a manipulator which can be used to take up individual wafers and transport them to the acceptance/transfer device.

**[0013]** It is thus possible to position the wafer with the aid of the handler after a prealignment in the  $\phi$  direction positionally correctly above the pins, which then accept/support the wafer, so that the handler can be removed again from the transfer/acceptance region above the chuck and the wafer can be deposited on the chuck and fixed by application of a vacuum. Afterwards, the stamp is then oriented with respect to the wafer with the aid of the alignment marks and the infrared (IR) positioning system and is pressed into the auxiliary patterning layer situated on the wafer, or the chuck is moved upwards against the stamp. During this operation,

the elevated information/structure on the stamp is imaged as a negative structure in the auxiliary patterning layer.

**[0014]** Finally, one refinement of the invention provides for the stamp to comprise a silicon wafer, so that the elevated patterning can be fabricated very cost-effectively by means of customary lithographic methods in conjunction with etching methods.

## BRIEF DESCRIPTION OF THE DRAWINGS

**[0015]** The invention is explained in more detail below using an exemplary embodiment. In the associated drawings:

**[0016]** Figure 1 shows a diagrammatic illustration of an arrangement according to the invention for transferring information/structures to wafers;

**[0017]** Figures 2 – 4 show a sequence illustrating the positioning of a wafer between a chuck and a stamp situated above it;

**[0018]** Figures 5 – 7 show a sequence illustrating the acceptance of the wafer by pins which can be extended from the chuck; and

**[0019]** Figures 8 – 10 show a sequence illustrating the transfer of the information/structures of the stamp to the wafer fixed on the chuck.

## DETAILED DESCRIPTION OF ILLUSTRATIVE EMBODIMENTS

[0020] The making and using of the presently preferred embodiments are discussed in detail below. It should be appreciated, however, that the present invention provides many applicable inventive concepts that can be embodied in a wide variety of specific contexts. The specific embodiments discussed are merely illustrative of specific ways to make and use the invention, and do not limit the scope of the invention.

[0021] In accordance with Figure 1, the arrangement for transferring information/structures to wafers 1 comprises a stamp 2 with an elevated structure 3, the dimensions of the stamp 2 approximately corresponding to those of the wafer 1. For example, the wafer 1 and the stamp 2 may have a diameter of about 200 mm (about 8 inches) or a diameter of about 300 mm (about 12 inches). It is anticipated that larger wafers 1, and therefore stamps 2, will be commercially available in the future.

[0022] The stamp 2 may comprise a silicon wafer, so that the elevated structure 3 can be fabricated by means of customary lithographic methods in conjunction with etching methods. As an alternative, the stamp 2 may also be fabricated from a plastic, for example a polymer, another semiconductor, for example germanium or gallium arsenide, or another material, for example quartz or sapphire.

[0023] The elevated structures 3 correspond to features that are to be transferred to the wafer 1. Accordingly, at least some of these structures 3 are preferably less than 0.1  $\mu\text{m}$ . For example, at least some of the structures 3 can be 50 nm or less in their smallest dimension parallel to the main surface of the wafer 1.

**[0024]** The wafer 1, to which the information/structure is to be transferred from the stamp 2 is fixed on a chuck 4 by application of a vacuum. Furthermore, the stamp 2 and the wafer 1 are provided with mutually assigned pairs of alignment marks 5, 6, 7, 8, so that the stamp 2 can be positioned in a predetermined position on the wafer 1 by means of an IR positioning system.

**[0025]** In order that the information/structure situated on the stamp 2 can be transferred to an auxiliary patterning layer 11 situated on the wafer, e.g. a plastically deformable auxiliary patterning layer such as a polymer layer or a resist, the stamp 2 is fixed to a preferably three-dimensionally movable stamp mount 12. The transfer of the information/structures from the stamp 2 to the auxiliary patterning layer 11 can then be effected simply by the elevated structure 3 of the stamp 2 being pressed into the auxiliary patterning layer 11, so that the structure 3 is imaged as a negative structure.

**[0026]** In the preferred embodiment, the alignment marks 5, 6, 7, 8 are embodied as buried metal marks in the stamp 2 and in the wafer 1, the metal marks in the wafer 1 being situated in the first structure plane or metal plane. The alignment marks 5, 6, 7, 8 are in each case arranged in the edge region of the stamp 2 and of the wafer 1 in a manner to take account of the fact that the alignment marks 5, 6, 7, 8 are not concealed again by metal interconnects/metal layers of further metallization planes in the course of further layer construction on the wafer 1.

**[0027]** In order now to enable a precise orientation of the stamp 2 with respect to the wafer 1, the IR positioning system in each case comprises an IR laser 13 in the chuck 4 and an IR camera 14 above the stamp 2.

**[0028]** As shown in Figures 2-7, there is situated between the chuck 4 and the stamp 2 a transfer/acceptance region for transferring/accepting a respective wafer 1 from/to a handler 16. Three pins 17, 18, 19 which can be extended from the chuck 4 from below against the wafer 1



are provided for the acceptance/transfer. Figures 2 – 4, which show a sequence illustrating the positioning of the wafer 1 between the chuck 4 and the stamp 2 and Figures 5-7, which show a sequence illustrating the acceptance of the wafer 1 by pins 17, 18, 19 that can be extended from the chuck 4.

[0029] Thus, the wafer 1 can be positioned with the aid of the handler 16 after a prealignment in the  $\phi$  direction positionally correctly above the pins 17, 18, 19 (Figures 2, 3), which then accept/support the wafer (Figures 4, 5, 6), so that the handler 16 can be removed again from the transfer/acceptance region 15 above the chuck (Figure 7) and the wafer 1 can be deposited on the chuck 4 and fixed by application of a vacuum.

[0030] Figures 8 – 10 show a sequence illustrating the transfer of the information structures of the stamp 2 to the wafer 1 fixed on the chuck 4. Referring to these figures, the stamp 2 is then oriented with respect to the wafer 1 with the aid of the alignment marks 5, 6, 7, 8 and the IR positioning system 9, 10 and pressed into the auxiliary patterning layer 11 situated on the wafer 1 (Figures 9, 10), or the chuck 4 is moved upwards against the stamp 2 (Figures 8, 10).

[0031] The plastically deformable auxiliary patterning layer (11) may comprise a polymer, a resist, or another suitable material.

[0032] The preferred embodiment of the invention achieves a significant reduction of the costs in the fabrication of the stamps 2 and at the same time obviates one complete photolithography step on the wafer. A significant cost saving is thus also achieved in wafer production.

[0033] While this invention has been described with reference to illustrative embodiments, this description is not intended to be construed in a limiting sense. Various modifications and

combinations of the illustrative embodiments, as well as other embodiments of the invention, will be apparent to persons skilled in the art upon reference to the description. It is therefore intended that the appended claims encompass any such modifications or embodiments.